Surviving urbanisation: maintaining bird species diversity in urban Melbourne

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Abstract
The relationships between vegetation and bird communities within an urban landscape are synthetised, based on a series of studies we conducted. Our studies indicate that streetscape vegetation plays an important role in influencing urban bird communities, with streetscapes dominated by native plants supporting communities with high native species richness and abundance, while exotic and newly-developed streetscapes support more introduced bird species and fewer native bird species. Native streetscapes can also provide important resources for certain groups of birds, such as nectarivores. Our research has also revealed that urban remnants are likely to support more native bird species if they are larger and if they contain components of riparian vegetation. Vegetation structure and quality does not appear to be as important a driver as remnant size in determining the richness of native bird communities. Introduced birds were shown to occur in remnants at low densities, irrespective of remnant size, when compared to densities found in streetscapes dominated by exotic vegetation. We discuss our results in terms of practical planning and management options to increase and maintain urban avian diversity and conclude by offering suggestions for future fields of research in terms of urban bird communities. (*The Victorian Naturalist* **126** (3), 2009, 73-78)

Keywords: urbanisation; bird assemblages; remnant vegetation; streetscapes; riparian zones

Introduction

Increasing urbanisation is a major threat to biodiversity, and as such there is considerable interest in mitigating its impacts on natural systems. The process of urbanisation converts natural and/or agricultural environments into 'novel', yet diverse, environments consisting of buildings, roads, streetscapes, open space and remnants of native vegetation. Research in Australia that documents how biodiversity responds to urbanisation is limited (for reviews see Lunney and Burgin 2004, Garden *et al.* 2006), and thus we have limited knowledge on how to manage urban environments to maintain biodiversity. Nonetheless, it is encouraging to see an increase in research interest in urban biodiversity, and particularly urban bird ecology, in recent years. Areas of research in Melbourne range from habitat preferences of bird communities (our work – see below), to human disturbance impacts (e.g. Platt and Lill 2006; Price and Lill 2008; Weston *et al.* 2009) to single species studies (e.g. Lowry and Lill 2007). This has been complemented by work in other Australian cities (e.g. Parsons *et al.* 2003, 2005; Daniels and Kirkpatrick 2006; Young *et al.* 2007) and a burgeoning international literature, as well as the appearance of specialised journals (e.g. *Urban Ecosystems, Landscape and Urban Planning*).

This paper utilises our previous research investigating the impacts of urbanisation on bird communities (i.e. Fitzsimons *et al.* 2003; White *et al.* 2005; Antos *et al.* 2006; Palmer *et al.* 2008) to highlight key findings and implications for conserving and promoting diversity in urban bird assemblages. Our research has examined the influence of streetscape vegetation on bird assemblages, the distribution of introduced birds within urban remnants and the key drivers of native avian species richness and composition within remnants. In this paper, we provide a synthesis of our findings and management recommendations.

Summary of methods and results

All research described in this paper was conducted in the eastern and south-eastern suburbs of Melbourne, within a 30 km radius of the CBD, during 2002-2004.

Birds in streetscapes

To conduct this study, the urban areas of Melbourne were broadly divided based on the dominant streetscape trees, and then compared to patches of remnant vegetation (also in the urban environment). The three streetscape types were those dominated by established native trees (not necessarily indigenous), streetscapes dominated by established exotic trees, and streetscapes in new suburbs where there was limited vegetation. In each of the four site types there were nine replicate sites, yielding a total of 36 sites. One hectare transects were established at each site and surveyed on three separate occasions. Each bird species was recorded and the average number of individuals of each species was determined in order to provide a measure of relative abundance. For a detailed description of the study, see White *et al.* (2005).

In this study we recorded 60 native species and seven introduced species. The bird community composition differed between each of the different types of sites. The richness of native bird species differed considerably between site types, with the lowest richness occurring in streetscapes with exotic trees and in new suburbs (Fig. 1). Both remnants and established native streetscapes had high richness of native species. A similar trend was observed for the abundance of native birds, with remnants and native streetscapes having higher abundances than exotic streetscapes and new developments (Fig. 1). The richness of introduced bird species was associated with the type of site, with remnants having low richness compared to all the streetscape types. The major difference, however, was observed when investigating the abundance of introduced birds. The abundance of introduced species was lowest in remnants, increased in native streetscapes, and was highest in exotic streetscapes. New streetscapes had intermediate levels between the exotic and native streetscapes, but were not significantly different from either (Fig. 1).

Another way of investigating community complexity is to compare the number of different feeding guilds represented in different types of sites. Overall, the highest numbers of guilds were represented in the remnant vegetation. Native streetscape areas were also well represented and supported most guilds found in remnants. There was, however, a considerable drop in the number of feeding guilds, and thus a drop in community complexity, in exotic streetscapes and new developments (Fig. 1). The major difference in guild composition between the native streetscapes and the exotic and new streetscapes was the reduction in insectivores and nectarivores in exotic and new streetscapes.

Some native bird species (e.g. lorikeets) were recorded in very high abundances in native streetscapes and appear to have been favoured by the planting of native, but non-indigenous, eucalypts (Fitzsimons *et al.* 2003). These non-indigenous eucalypts are generally more profuse flowerers than indigenous eucalypts, and lorikeets have been shown to preferentially select them in urban areas (e.g. Smith and Lill 2008, Stanford and Lill 2008).

Overall, these findings, and similar recent findings in Adelaide by Young *et al.* (2007), suggest that the type of streetscape planting has a considerable influence on bird communities. Streetscapes supporting native vegetation, be it remnant or planted, support richer bird assemblages dominated by native species, and provide effective 'nature strips' for at least some native bird species.

Birds in remnant vegetation

Thirty-nine remnants of native vegetation were surveyed for birds in this study. The remnants ranged in size from 1 ha to 107 ha. These sites were surveyed four times each during both the breeding season and non-breeding season for both native and introduced bird species. We excluded aquatic bird species from any comparisons because many remnants did not have aquatic habitats (for detailed methods see Antos *et al.* (2005) and Palmer *et al.* (2008)). Overall, introduced birds did not demonstrate any major trends in abundance and distribution in urban remnant vegetation. Whilst the composition changed with increasing remnant size, the relative abundance of introduced birds was largely unaffected by remnant size (Antos *et al.* 2005). In general the abundance of introduced birds was very low in urban remnants when compared to streetscape vegetation.

In this study 79 native woodland bird species were recorded (see Palmer *et al.* 2008 for details). The richness of birds in remnants was strongly influenced by the size of the remnant patch (Fig. 2). In general, almost all remnants had a base bird community

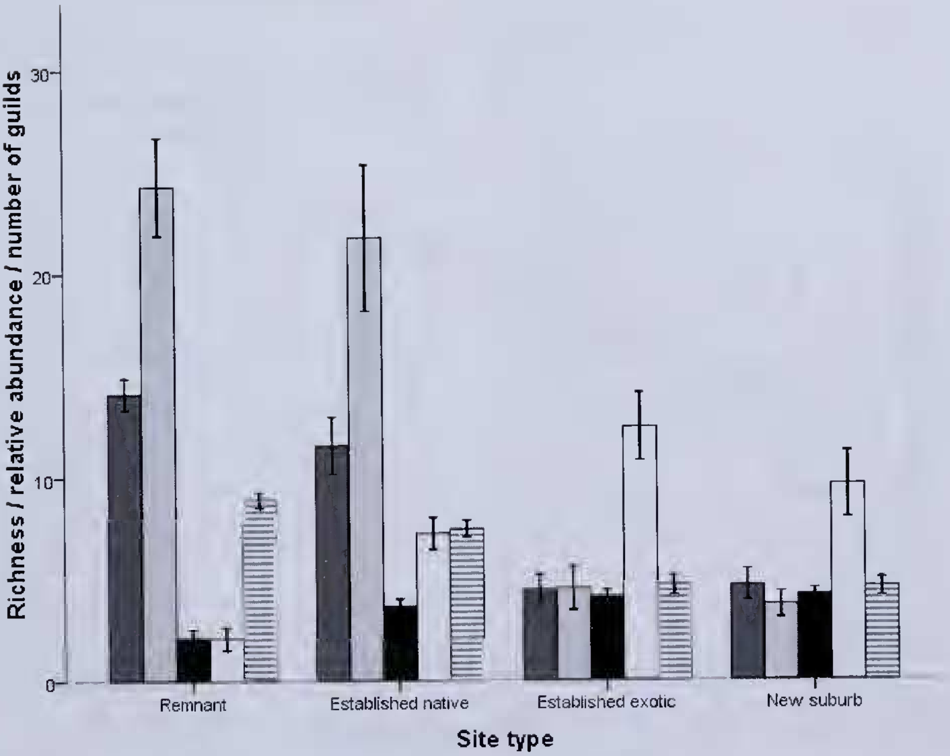

Fig. 1. The influence of different urban sites on bird community composition (Mean ± 1SE). Dark grey bars = number of native species; light grey bars = relative abundance of native species (birds/ha); black bars = number of introduced species; white bars = relative abundance of introduced species (birds/ha); horizontally striped bars = number of feeding guilds. After White *et al.* (2005).

consisting of nine species, these being Red Wattlebird *Anthochaera carunculata*, Rainbow Lorikeet *Trichoglossus haematodus*, Eastern Rosella *Platycercus eximius*, Australian Magpie *Cracticus tibicen*, Spotted Pardalote *Pardalotus punctatus*, Little Raven *Corvus mellori*, Brown Thornbill *Acanthiza pusilla*, Noisy Miner *Manorina melanocephala* and Grey Butcherbird *Cracticus torquatus*. All these species were also well represented in streetscape sites, which suggests they are reasonably tolerant of the urban matrix. All native species recorded within the remnants were classified into categories ('all species', 'urban tolerant', 'urban sensitive', 'ground foragers', 'shrub foragers', 'canopy foragers' and 'migrants') and assessed against a series of parameters associated with the remnant patches (e.g. remnant size, amount of surrounding vegetation, vegetation life-form cover etc). All these different groupings (excluding 'urban tolerant' species) showed strong positive relationships between richness and the size of the remnant, adding further support for the finding that the size of a remnant is critical for bird diversity (Table 1). The richness of most groupings of birds was not significantly affected by the quality of either the ground vegetation or the canopy and shrub layer (Table 1). With the exception of the richness of migrant species, most species were not influenced by the amount of remnant vegetation in a 500 m radius around each remnant. Other than remnant size, the only aspect of the remnant that affected richness of species was the amount of riparian vegetation within the remnant. Riparian vegetation may be more productive for birds, but also may be providing connectivity between remnants, as remnant vegetation often occurs along creeklines in the urban landscape studied.

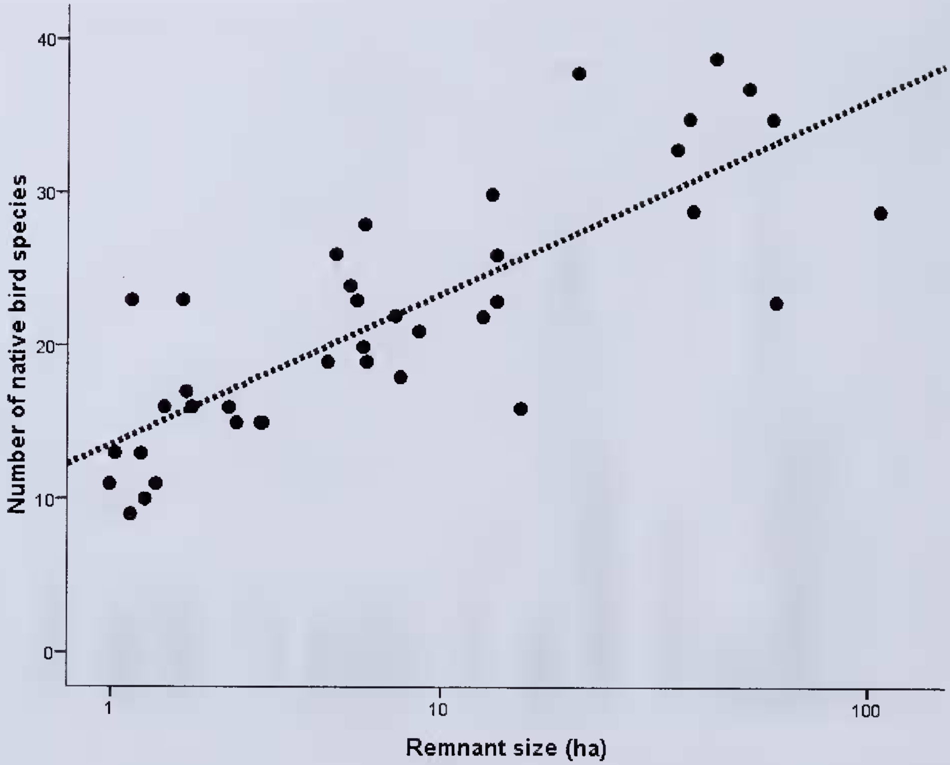

Fig. 2. Relationship between native woodland bird species richness and remnant size based on the 39 remnants examined by Palmer *et al.* (2008).

Table 1. Relative strength of relationship between avian ecological groups and habitat variables within urban vegetation remnants. +++ = strong positive relationship, ++ = moderate positive relationship, + = weak positive relationship. Blank cells indicate no detectable differences. After Palmer *et al.* (2008).

Type of species	Remnant size	Canopy shrub complexity	Ground layer complexity	% vegetation in surrounding landscape	% riparian vegetation
All species	+++				++
Urban tolerant species	+				
Remnant reliant species	+++				+
Ground foragers	+++				
Shrub foragers	++	++			
Canopy foragers	+++				++
Migrants	+++			++	

Practical opportunities for planning and management

The findings outlined above provide directions for both urban planners and residents to increase urban bird diversity in Melbourne and other urban areas. Some key principles include:

- Protect all remnants of native vegetation, which are the base for urban biodiversity;
- Initially focus on increasing the size of remnants by revegetation or reservation of the largest area available (where applicable);
  - Increasing the size of the remnant appears more important than improving vegetation quality;
- Turn streetscapes into 'nature strips';
  - Plant native trees and replace, or at least supplement, exotic trees with native trees;
  - Reduce exotic grass cover and replace with shrubs and native ground cover to enhance nature strips for native birds (see Parsons 2007);
- Increase native vegetation in residential gardens and areas of community open space.

There are a number of opportunities in Melbourne's growth corridors (e.g. Cranbourne-Pakenham growth corridor) to plan viable reserves within existing and proposed residential developments, and we need to make the most of these. Making the findings of urban biodiversity research accessible to key stakeholders and planners will be important for this to happen.

A review of public land use by the Victorian Environmental Assessment Council (VEAC) is currently under way across urban Melbourne (see <www.veac.vic.gov.au> for more details). This body, and its predecessors, the Land Conservation Council and Environment Conservation Council, have been responsible for the creation of most of the present day park and reserve system across the state but these bodies have not previously made recommendations concerning public land use in Melbourne. Many important larger remnants occur in areas not currently reserved and/or managed for conservation, such as on freeway reservations. The results of our research suggest that consolidating larger areas of native vegetation in single and, if possible, connected systems, will provide for a greater diversity of native bird species, and should be considered seriously by VEAC and other urban land-use planners.

Future research

As systematic research into urban bird ecology is still in its relative infancy, many areas are in need of future research. We outline some of these below:

- The research described above considered the responses to urbanisation of diurnal birds of forests and woodlands. Further work is required to determine the impact of urbanisation on bird communities of other habitats such as wetlands, coastal areas and grasslands, particularly as many of these are still being cleared to make way for urban development (e.g. Williams *et al.* 2001, 2005). Although some work has been done on the distribution of nocturnal birds in Melbourne (e.g. Cooke *et al.* 2006, Isaac *et al.* 2008), further work is required;
- There is a greater need to document baseline presence/absence and relative abundance at identifiable sites, to enable changes in bird populations to be quantified over time (for example, see van Polanen Petel and Lill 2004, Platt and Lill 2006, Coates and Harris 2008). Changes could result from a number of factors, including extinction debt, increased fragmentation through loss of habitat, habitat degradation, increased or decreased competition, and climate change;
- There is a need to understand the underlying ecological mechanisms that determine the structure and composition, as well as long-term viability, of urban bird assemblages. Does the urban landscape support adequate food and breeding resources to maintain species in the longer term? For example, what is the long-term prognosis for the availability of tree hollow and the species that rely on them?
- In agricultural and forest production landscapes, there has been strong emphasis on managing and reducing the hostility of the matrix and ameliorating edge effects on vegetation remnants. Similar attention needs to be directed to understanding the role and function of 'off-reserve' vegetation in urban landscapes in promoting biodiversity, including vegetation in backyards;
- In researching aspects of introduced bird species in urban remnants, it became evident that there was a dearth of research and understanding on the ecology and impact of introduced bird species in Australia, despite general derision. For instance, the Common

Myna *Sturnus tristis* is generally considered to affect native bird species negatively as it has been shown to compete for nesting hollows (Pell and Tidemann 1997). However, it was found not to compete for food resources in Melbourne (Crisp and Lill 2006);

- A better understanding of movements and dispersal of individuals and species between urban remnants, within the urban matrix and between the urban area and beyond, is required;
- Predictions of what may happen next: if the influx of some native bird species that we are seeing today is the result of what has been planted in the 1960s-70s and the design of suburbs and reserves at the time, then what can current planning and planting tell us about the next 30 years? We need to investigate ways in which we can influence today's planning and planting to ensure that biodiversity benefits continue to increase well into the future;
- One of the great assets of cities and urban areas is the human population size – large numbers of people on hand to regularly participate in long-term surveys of urban remnants or elsewhere in the urban matrix (e.g. Birds in Backyards program). Research institutions and local governments should investigate the opportunity to harness this resource.

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